Name _____

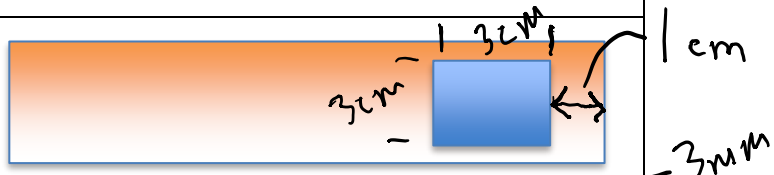
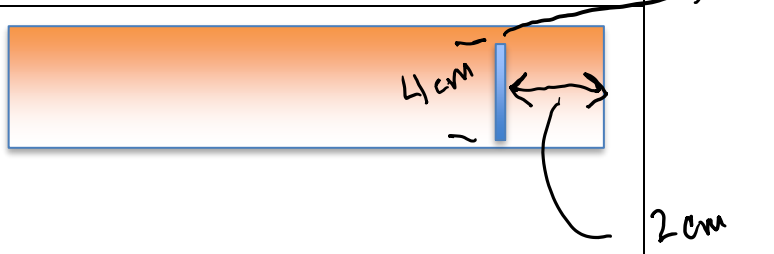
Interpreting the Hydrogen Emission Spectrum

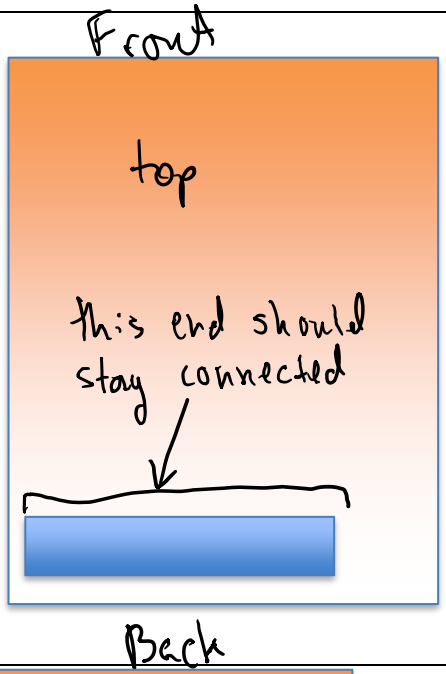
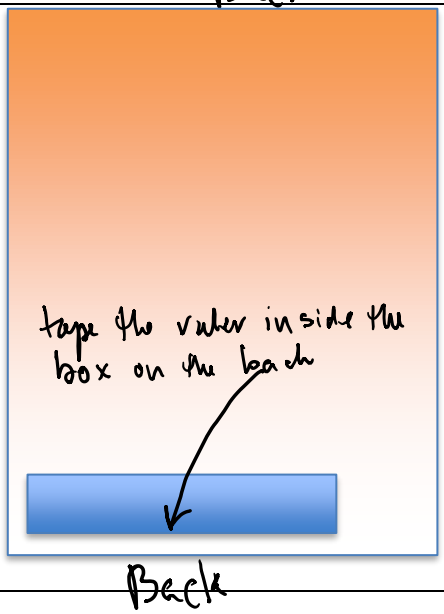
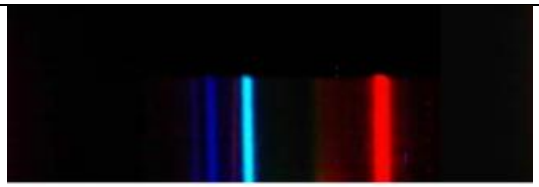
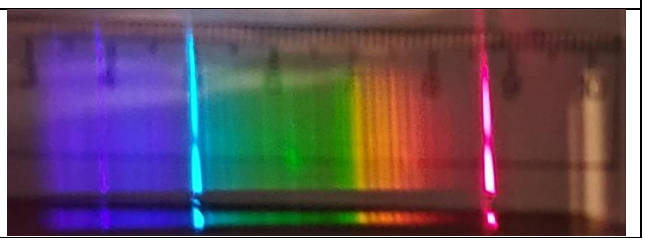
Your Tasks (Mark these off as you go)

- ☐ Build a visible spectrometer
- ☐ Record the spectral lines for mercury
- ☐ Make a calibration graph
- ☐ Determine the wavelengths of the hydrogen spectral lines
- ☐ Interpret your results
- ☐ Write a conclusion
- ☐ Receive credit for this lab

❑ Build a visible spectrometer

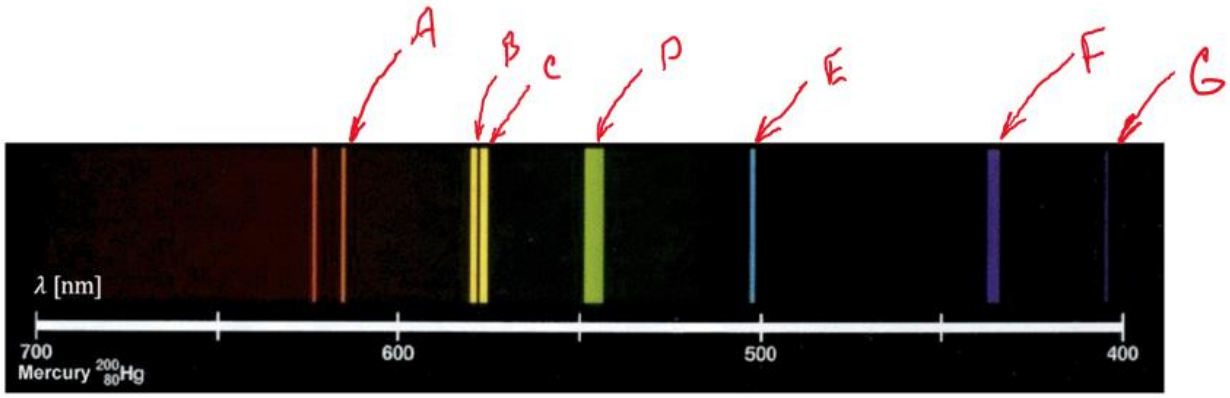
A visible spectrometer is a scientific instrument used to separate and measure the visible components of different light sources. Follow the instructions below to build your own!

Obtain a box. A cereal box works great, but any box of similar shape will also work. Once you have your box, - Tape your box together so that there are no openings - lab the box as shown. Make sure you label one side as "front", another as "top", and another as "back".	
Turn you box so that the front faces you and the top is facing up. Cut a 3 x 3 cm square in the front of your box as shown.	
Turn your box around so that the back faces you and the top is facing up. Cut a 4 x 3 mm slit in the back of your box as shown.	

Orientate your box so that back faces you and the top is facing up. Cut a flap in the top of your box as shown.	
Cut out a copy of a ruler. Open the flap and secure the ruler to the inside of the box along the back.	
Obtain a piece of diffraction grating and tape the grating over the 3 cm x 3 cm hole in the front of your box.	
Test your spectrometer. Point your spectrometer at the hydrogen light source and align the light source with the slit. Look through the window. If you see the distinct bands of hydrogen your spectrometer works. If you do not, rotate the diffraction grating by 90 degrees and try again.	
Finally, you need to make sure the lines of your spectrum land on the ruler you secured on the inside of your spectrometer (See the image to the right). Open the flap on top of your spectrometer to allow some light in your box. Do the lines appear on the ruler? If not, you will need to fine tune your spectrometer so they do.	

❑ Record the spectral lines for mercury

Just like hydrogen, mercury also produces a unique pattern of lights. A convenient source of mercury are fluorescent lights. The emission spectrum for mercury is shown below.



In the data table below, record the wavelength of the following mercury spectral line

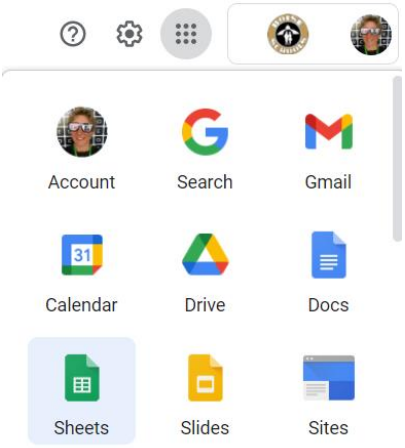
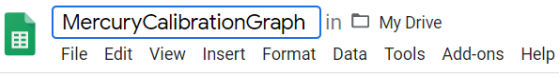
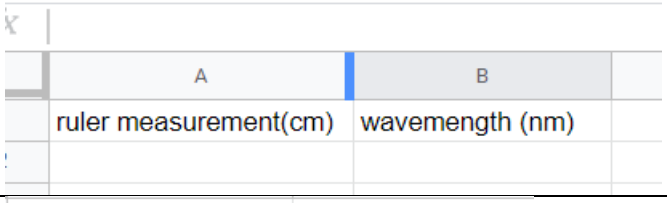
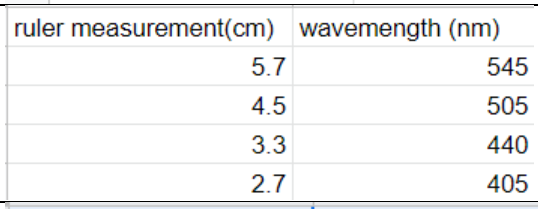
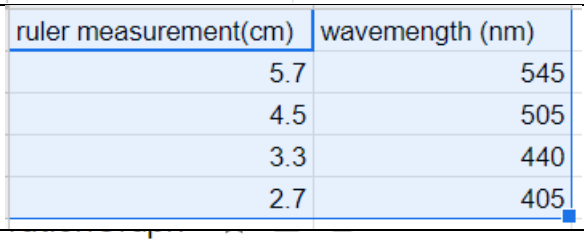
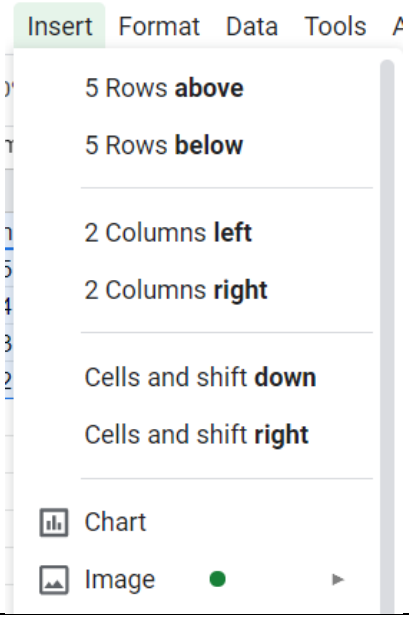
Line	Wavelength
A	
B	
C	
D	
E	
F	
G	

Locate the fluorescent light source in the classroom. Hold and adjust your spectrometer until the mercury spectrum is visible. Using the camera on your phone, take a picture of the spectrum. Make sure the ruler guides are also visible in your picture. Insert the picture of your spectrum below.

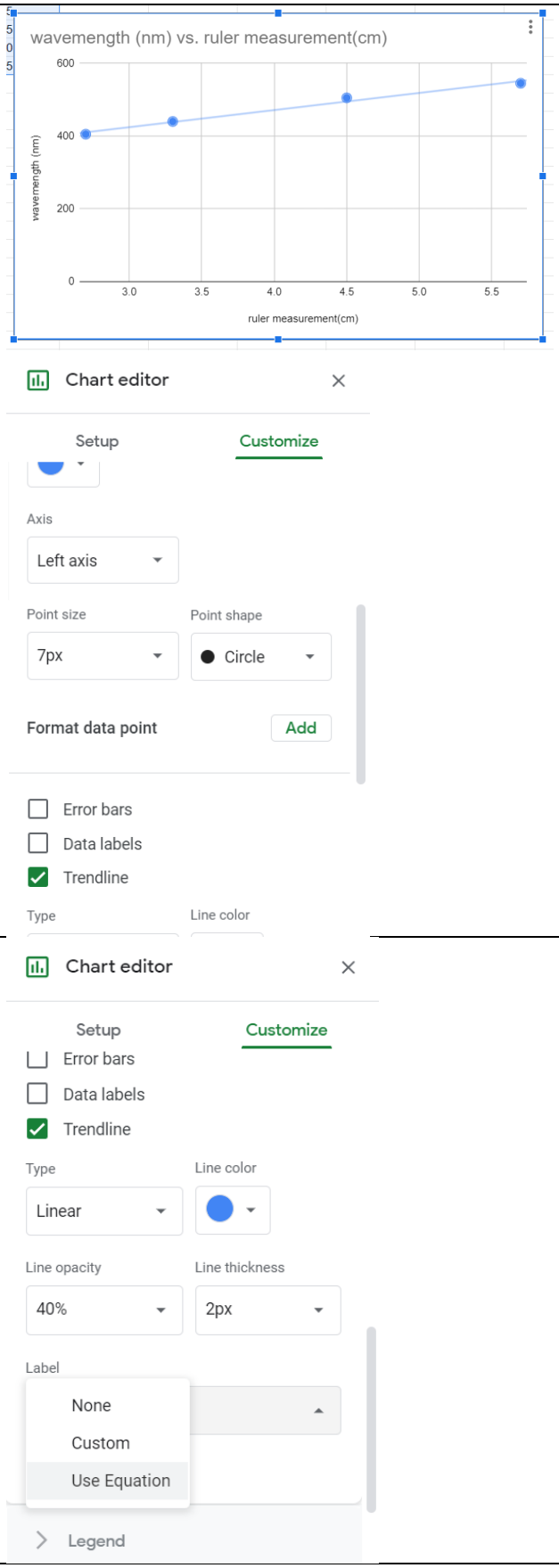
Locate as many of the mercury spectral lines as you can – use the picture of the mercury spectrum above as a guide. Keep in mind you may not see all the lines, some lines may appear blurred together, or you may see additional lines due to light contamination. In the space below, record the color of each line, the location on the ruler, and it the wavelength.

Line color	Ruler measurement	Wavelength

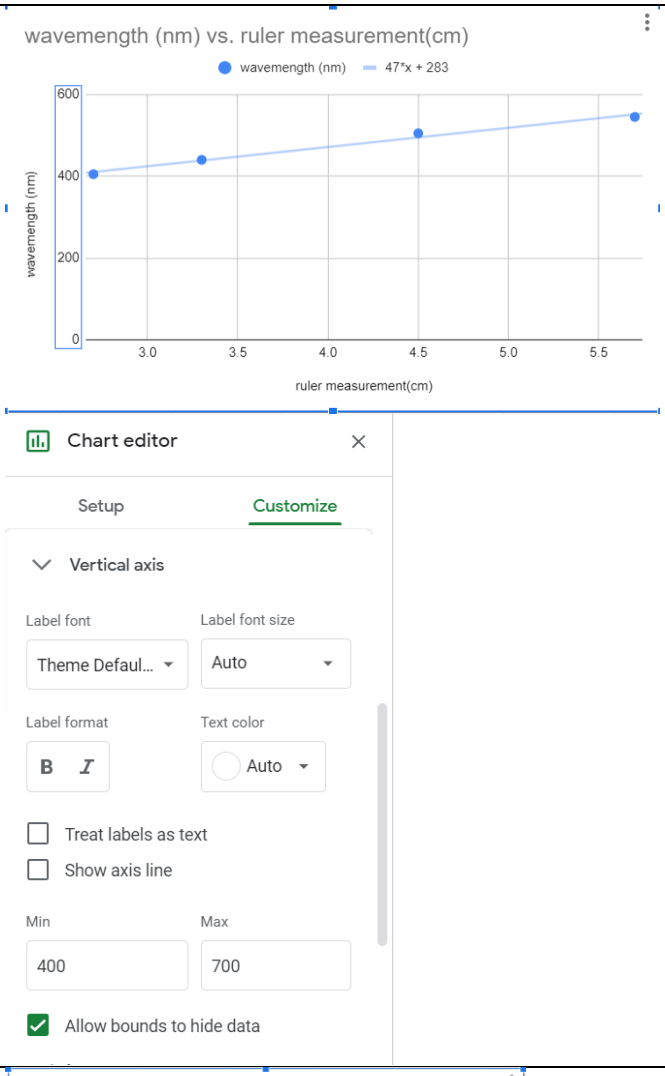
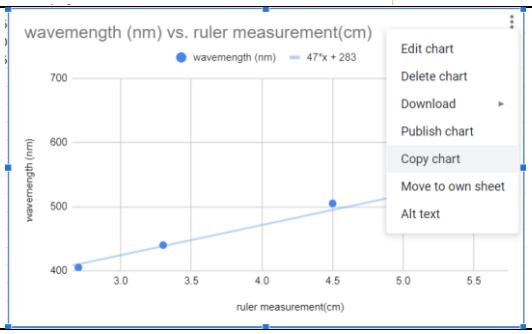
❑ Make a calibration graph

We will be using Google Sheets to make our calibration graphs. Locate Google Sheets and open a blank sheet.	
Give your Sheet a name	
Title columns A and B as shown. Note, you can change the width of a column by selecting the edge and dragging.	
For each of the mercury spectral lines you identified, enter the ruler measurement and the corresponding wavelength. Do not include units.	
Highlight your data as shown right.	
From the *Insert* menu, select *Chart*.	

To add a trendline, click on a data point. Then, in the menu to the right, scroll down until you locate the trendline check box and select it.



To add an equation for your line, continue to scroll down in the right menu until you locate the *Label* menu. From the menu select *Use Equation*.

Notice the y-axis of your graph. The wavelengths begin at 0. We only want to display the wavelengths in the visible region on this scale. To change the scale, click on the numbers on the y-axis A new menu on the right appears. In the Min and Max boxes, type 400 and 700, respectively.	
Copy your completed calibration graph and paste it below.	

Paste your completed calibration graph below.

❑ Determine the wavelengths of the hydrogen spectral lines

Locate the hydrogen light source in the classroom. Hold and adjust your spectrometer until the hydrogen spectrum is visible. Using the camera on your phone, take a picture of the spectrum. Make sure the ruler guides are also visible in your picture. Insert the picture of your spectrum below.

Locate the spectral lines for hydrogen. Record their location on the ruler.

Line color	**Ruler measurement**
Red	
Blue green	
Blue violet	
Violet	

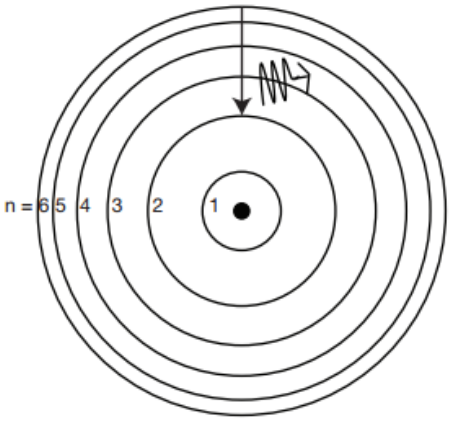
Use the equation of the line from your graph to determine the wavelength of each line. To do this substitute the ruler measurement for x and solve for the wavelength. Record your results below,

Line color	**Wavelength**
Red	
Blue green	
Blue violet	
Violet	

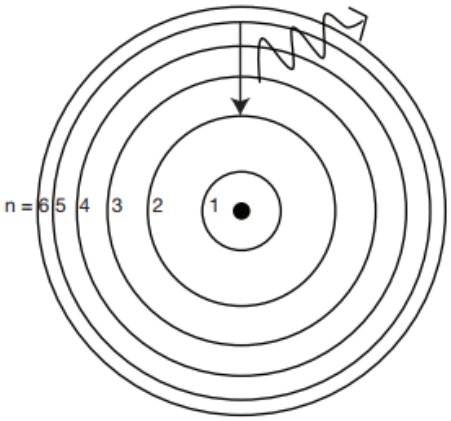
❑ Interpret your results

The diagrams below show the allowed transitions in the hydrogen atom. Refer to the diagrams to complete the questions that follow.

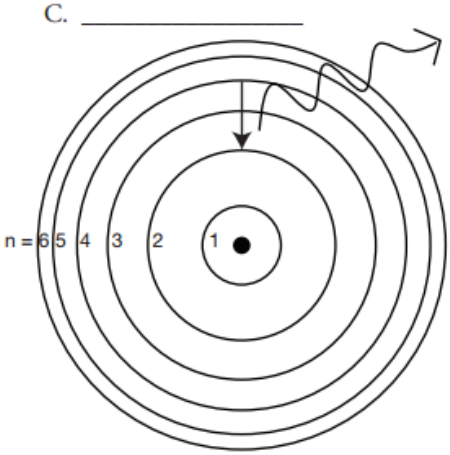
A. _____



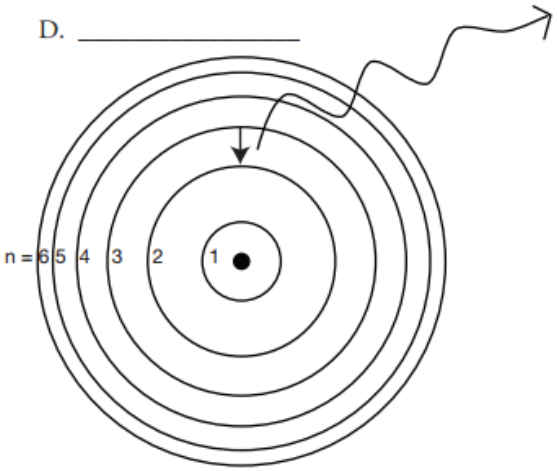
B. _____



C. _____



D. _____



(i) Complete the following table.

Picture	**Transition**	**Color of light**	**Order of energy (1 = lowest)**
A	n= to n=		
B	n= to n=		
C	n= to n=		
D	n= to n=		

(ii) What is the relationship between the transition and energy of light emitted? In other words, as the length of the transition increases, does the energy that is emitted increase or decrease?

The actual wavelengths for the spectral lines of hydrogen are given below,

	Actual wavelength (nm)
red	656
blue green	486
blue violet	434
violet	410

Calculate the percent error associated with each line using the formula below. Record your results in the table below.

$$\% \text{ Error} = \left| \frac{\text{Theoretical Value} - \text{Experimental Value}}{\text{Theoretical Value}} \right| \text{X } 100$$

Theoretical Value = Actual ... Known ...True Value

Line color	**Percent error**
Red	
Blue green	
Blue violet	
Violet	

❑ Write a conclusion

A conclusion is a concise summary of the lab. A conclusion should include the following elements (1) The purpose of the lab, (2) A summary of what you did to accomplish the purpose (3) A summary of your results (4) A summary of errors.

In the space below, use complete sentences to summarize the purpose of this lab.

In the space below, use complete sentences to describe what you did to accomplish the purpose. You could say for example, "In this lab, we build a spectrometer out of a cardboard box. We used the spectrometer to first…."

In the space below, use complete sentences to summarize your results. You could say for example, "We determine the wavelengths of the spectral lines for hydrogen to be…"… "The percent error associated with each line is ….".

In the space below, provide a summary of errors. Experimental errors are errors that result due to flaws in the experimental design. For example, we did not perform the experiment in a completely dark room and therefore experienced interference from other light sources. Can you think of others? Indicate at least two sources of errors and how they affected your results.

❑ Receive Credit for this lab

Submit your completed lab to receive credit.